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Developing Expectations for Wisconsin Streams

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What should healthy streams be like?



Overview:

- Classification evaluated
- Reach – specific modeling (RF)
- Reference sites limitations

What Are Reference Conditions?*

- Pristine?
- Historical?
- Minimally - disturbed?
- Least - disturbed?
- Best - attainable?
- Other?

*After Stoddard et al. 2006

This Study:

- Pristine Conditions
- Historical Conditions
- Minimally - disturbed
- Least - disturbed
- Best - Attainable Conditions
- Current conditions

Reference Condition Measures

Stream Habitat

Fish Habitat Suitability Index
Width / Depth Ratio
Percent Fine Sediment
Percent Rocky Substrate
Percent Fish Cover

Water Chemistry

Phosphorus

Nitrogen

Dissolved Inorganic Nitrogen
Total Suspended Solids
Conductivity
Transparency
Dissolved Oxygen

Fish

Fish IBI
Percent Simple Lithophiles
Number Intolerant Species
Percent Tolerant Individuals

Macroinvertebrates

Hilsenhoff's Biotic Index

Macroinvertebrate IBI
Species Richness
Percent EPT Taxa
Percent Chironomidae
Functional Feeding Groups

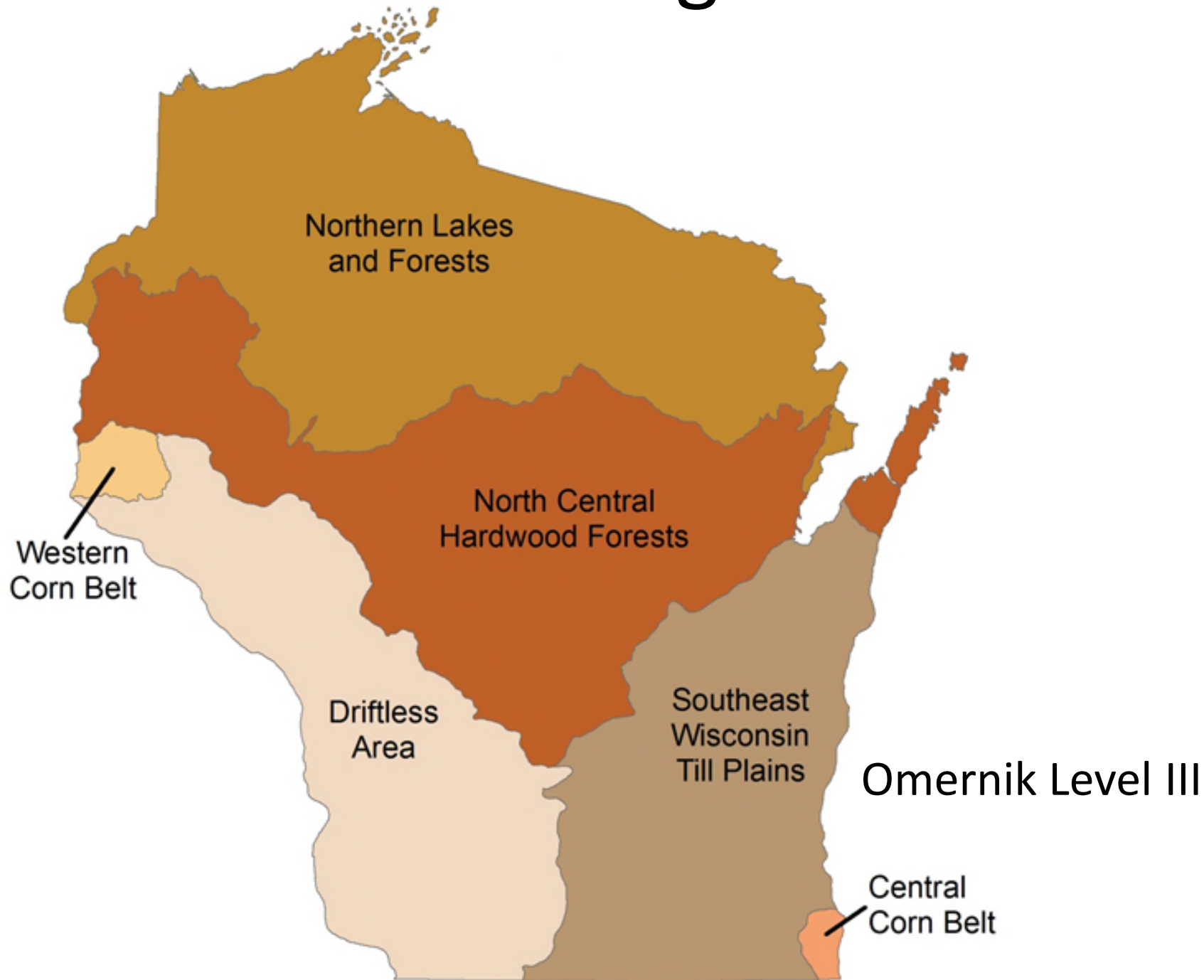
Overview:

- Classification
- Reach – specific modeling
- Reference sites limitations

Stream Classes:

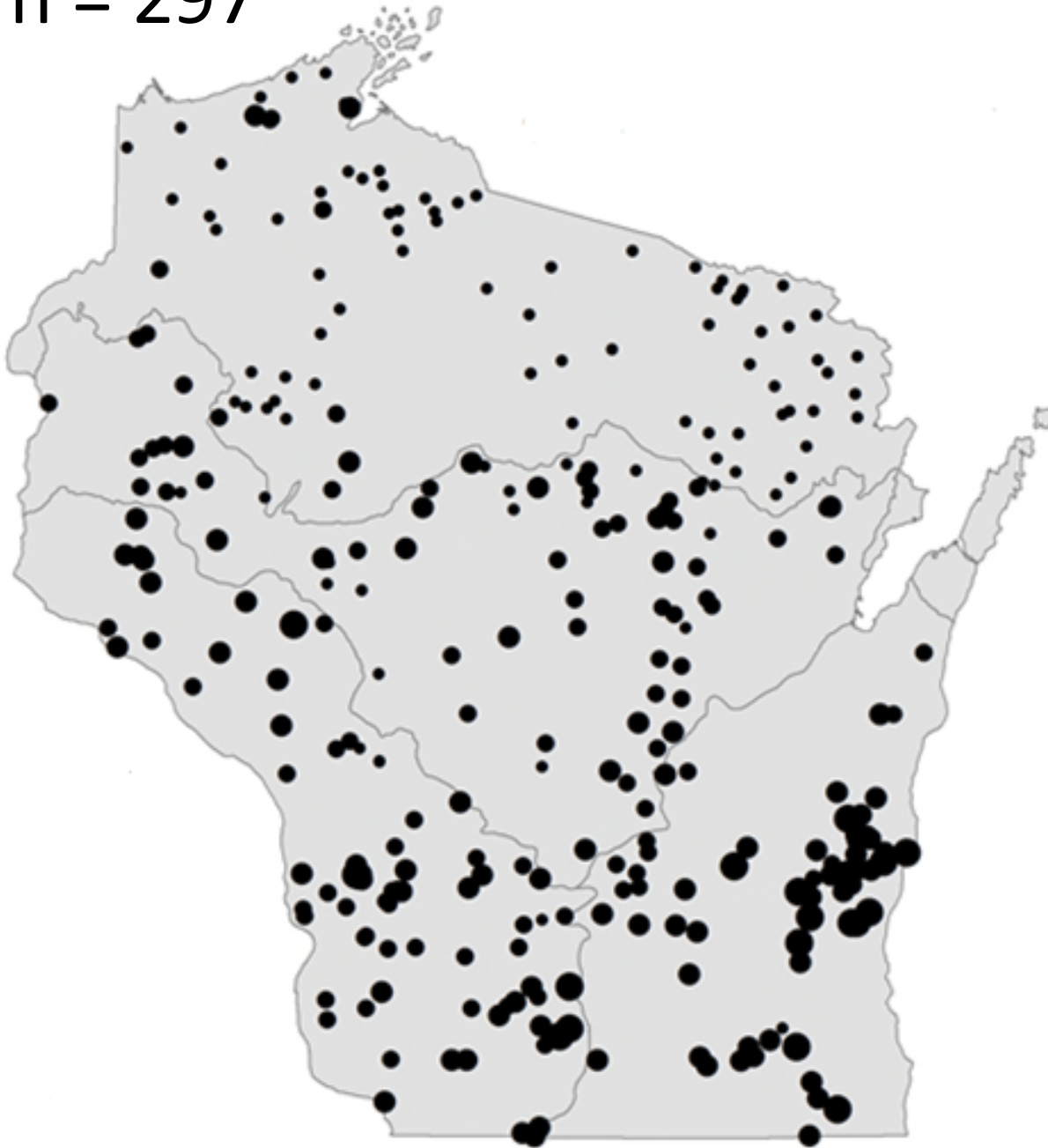
- Ecoregions (4)
- Flow volume (2)
- Thermal class (4)

Ecoregional Classification



Least – Disturbed Stream Sites Data

n = 297



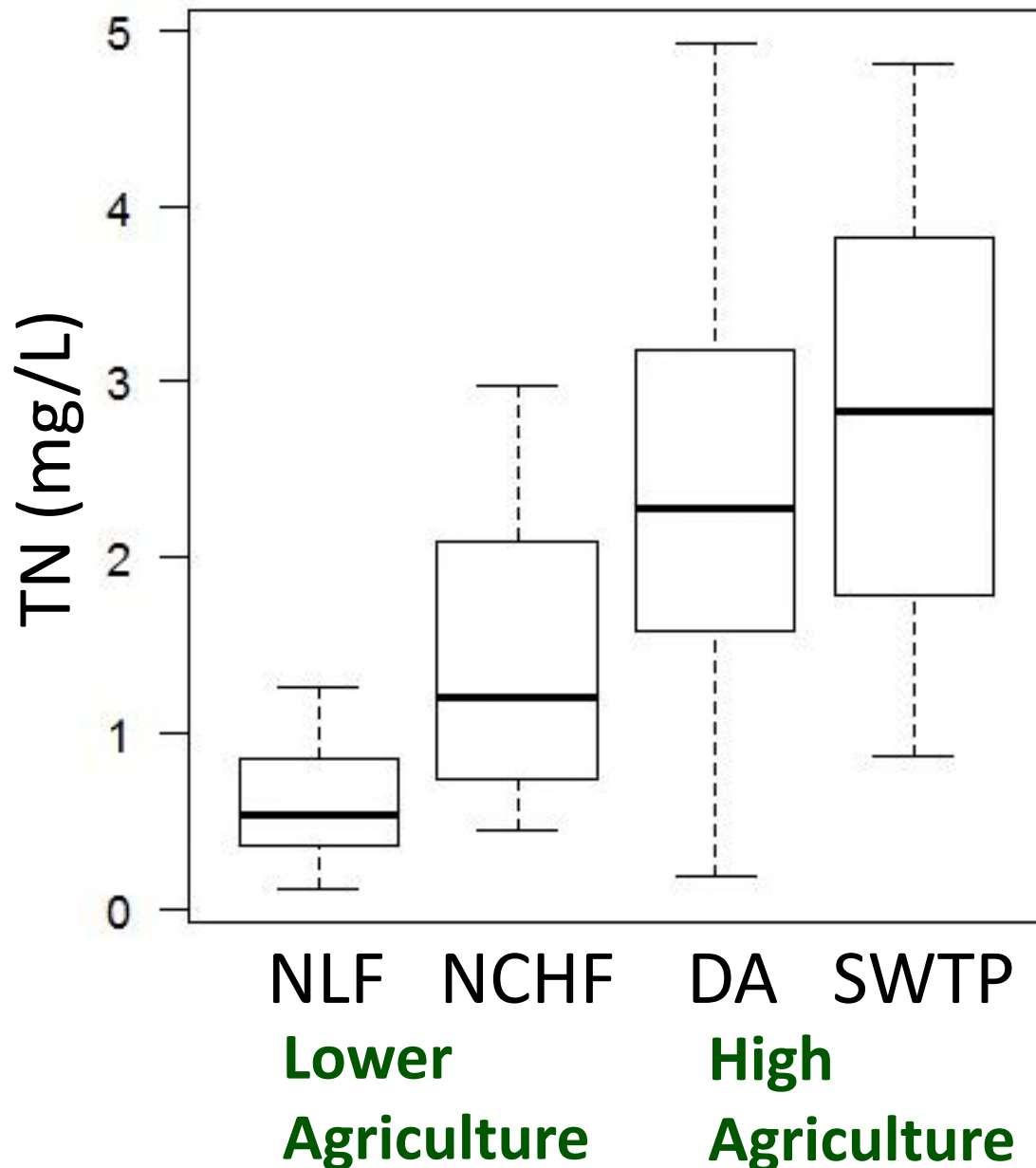
Limitations:

- Varying quality
- Unrepresentative
- Moving target

Overview:

- Classification methods evaluated (just two examples)
- Reach – specific modeling
- Reference sites limitations

Ecoregional Classification Results

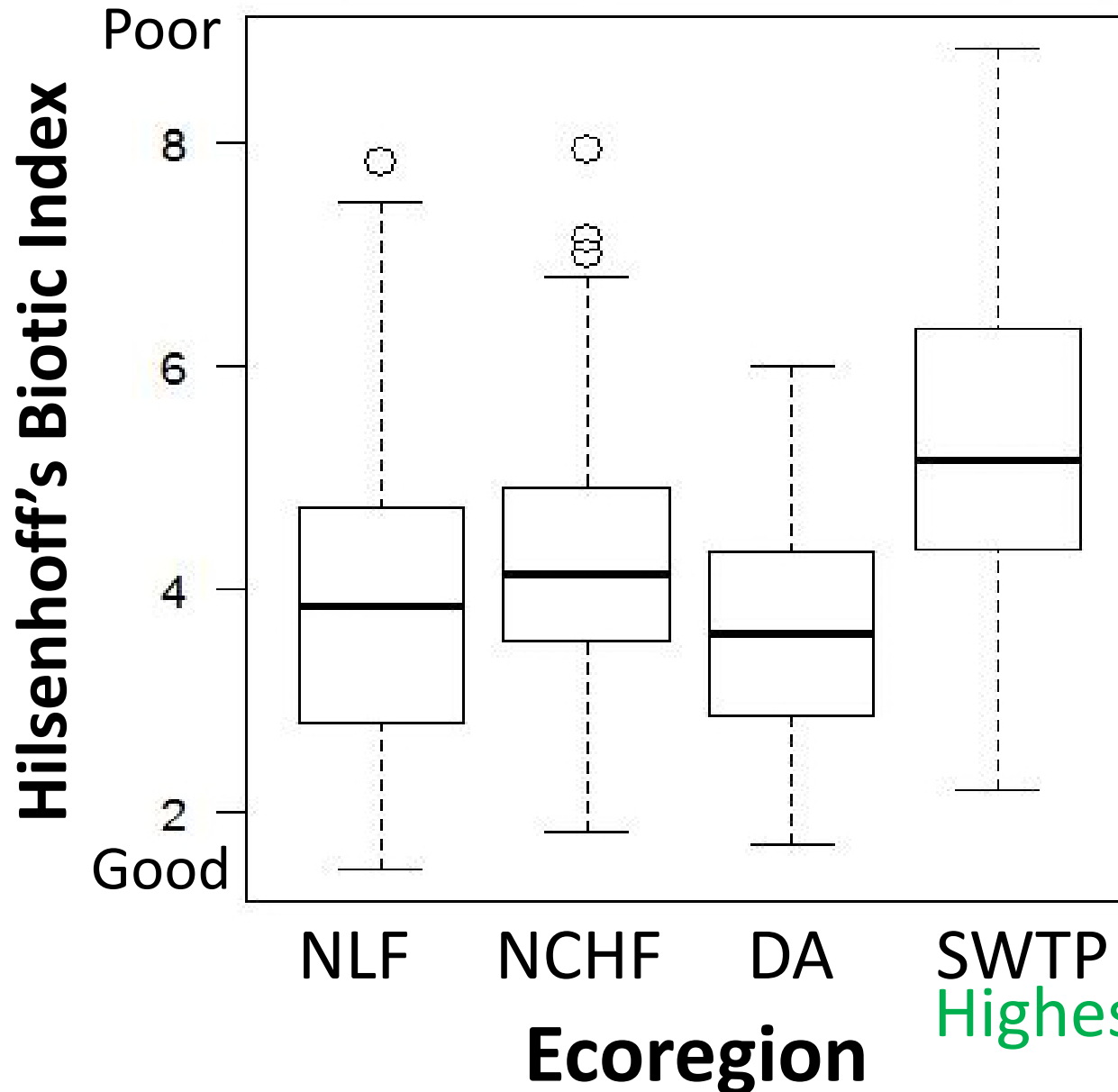


Ecoregional differences often exist, but ...

- Natural factors?
- **Anthropogenic** factors?

Within class variability usually large

Ecoregional Classification Results

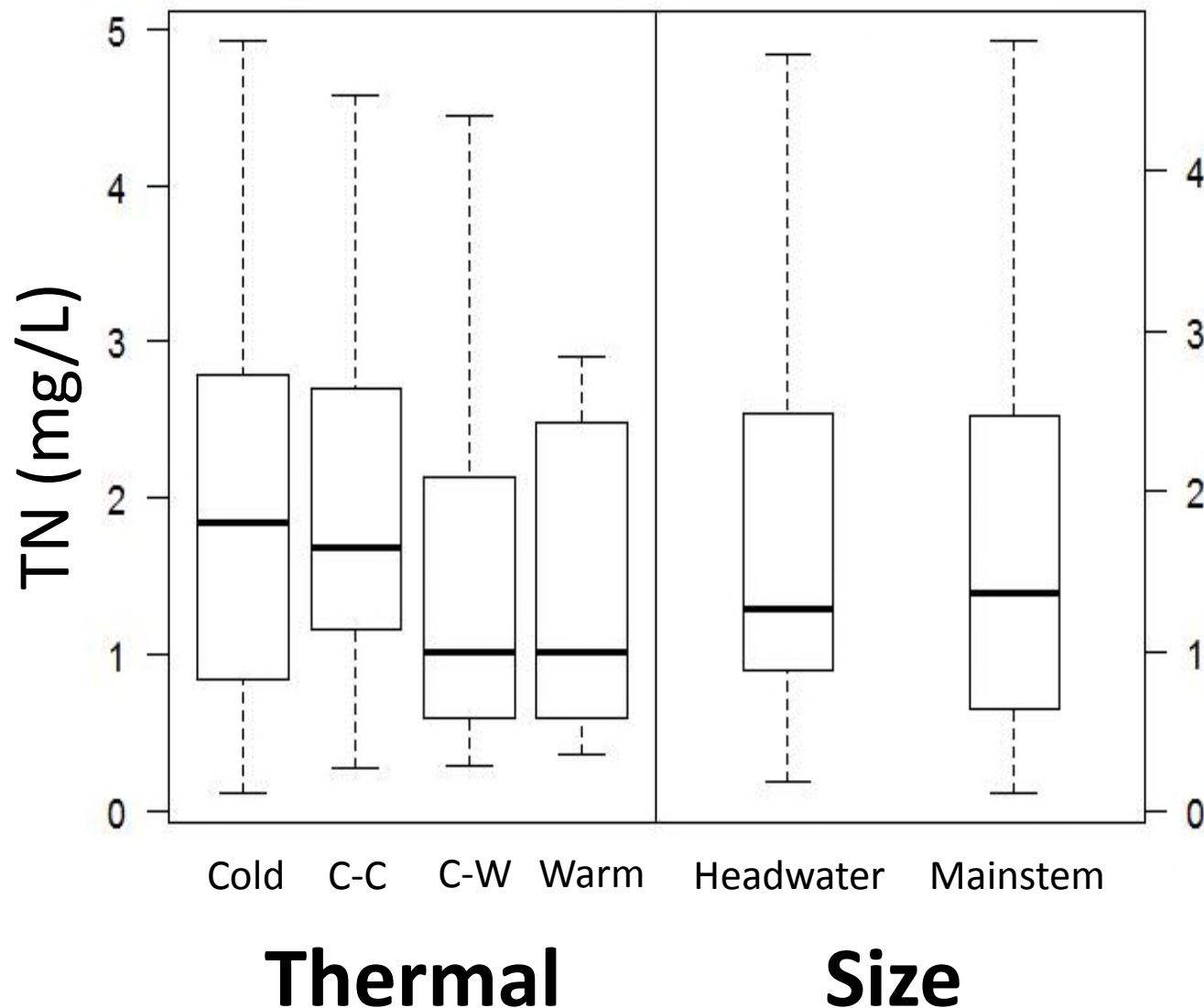


Only SWTP distinct

- Natural factors?
- Anthropogenic?

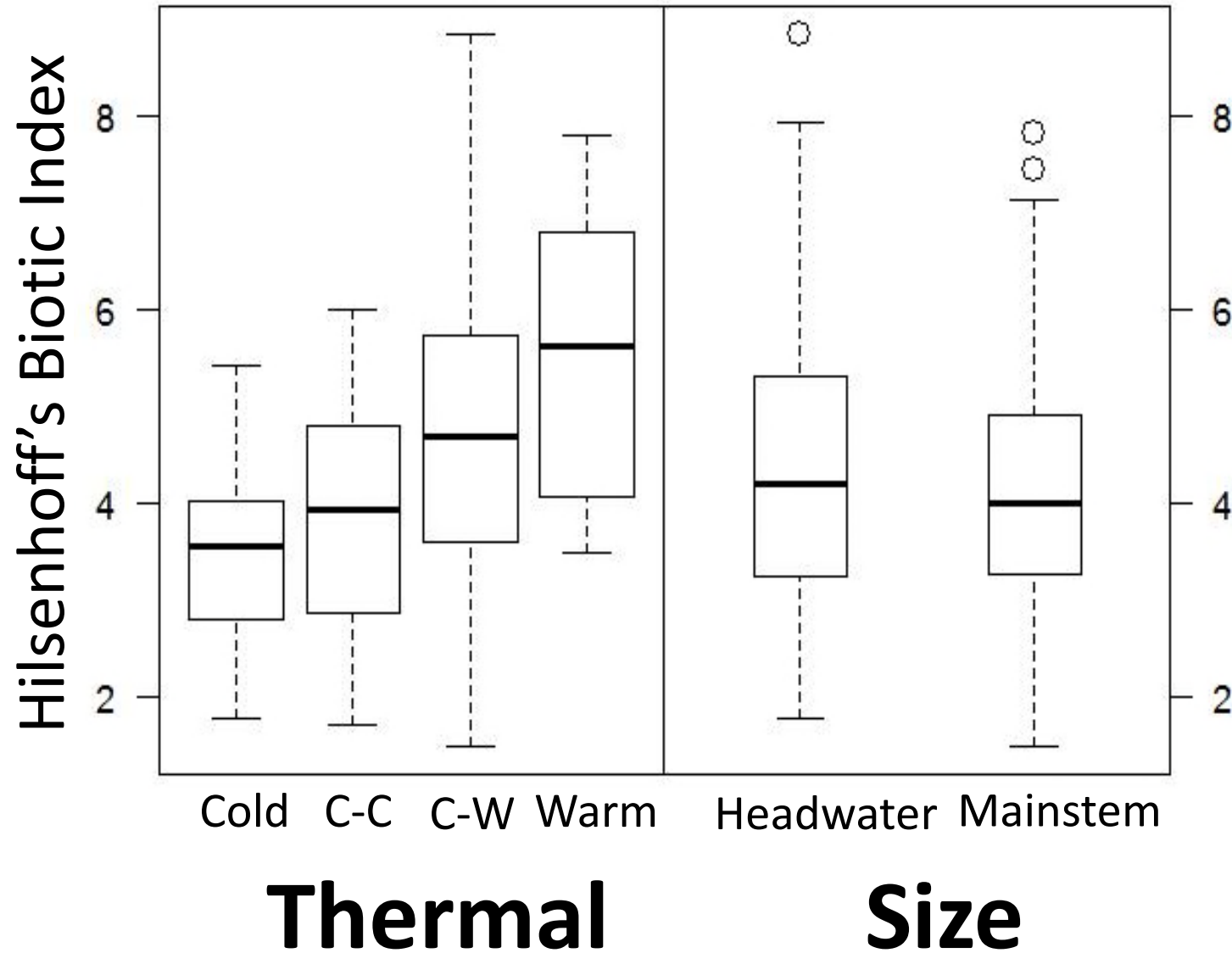
Highest Ag, Urban

Typologic Classification Results



- No thermal or size class differences
- Within - class variability often large

Typologic Classification Results



- Cold and warm streams different
- Stream sizes not different

Conclusion #1

- Classification results not great
- Ecoregions may differentiate streams, but. . .

Potential solution:

Develop reach - specific expectations

Random Forests Models

Inputs:

- Stream monitoring data
- Watershed and channel characteristics

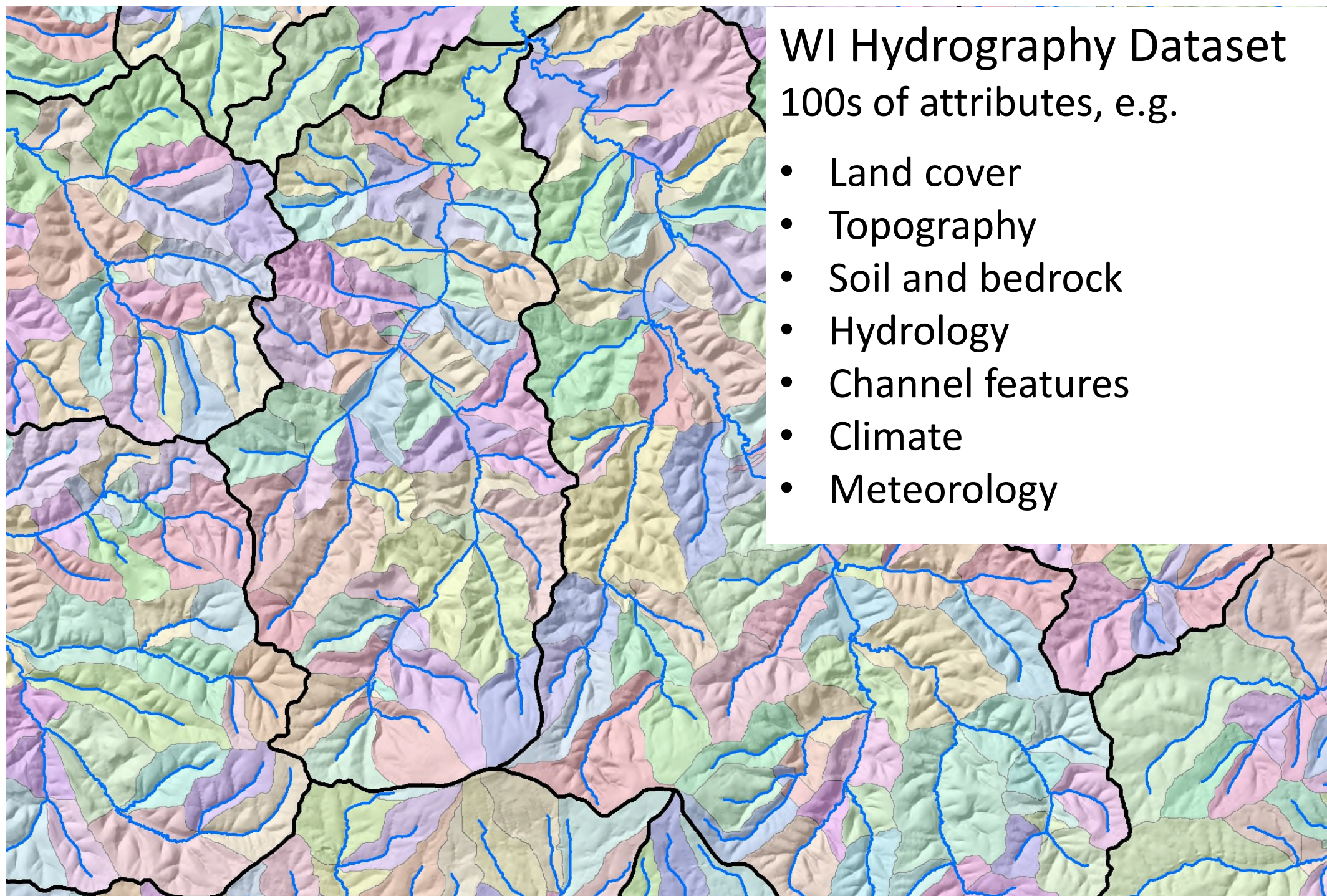
Outputs:

- Stream reach predictions ($n = 110,000$)
- Identification of key predictor variables

Watershed and channel predictor variables

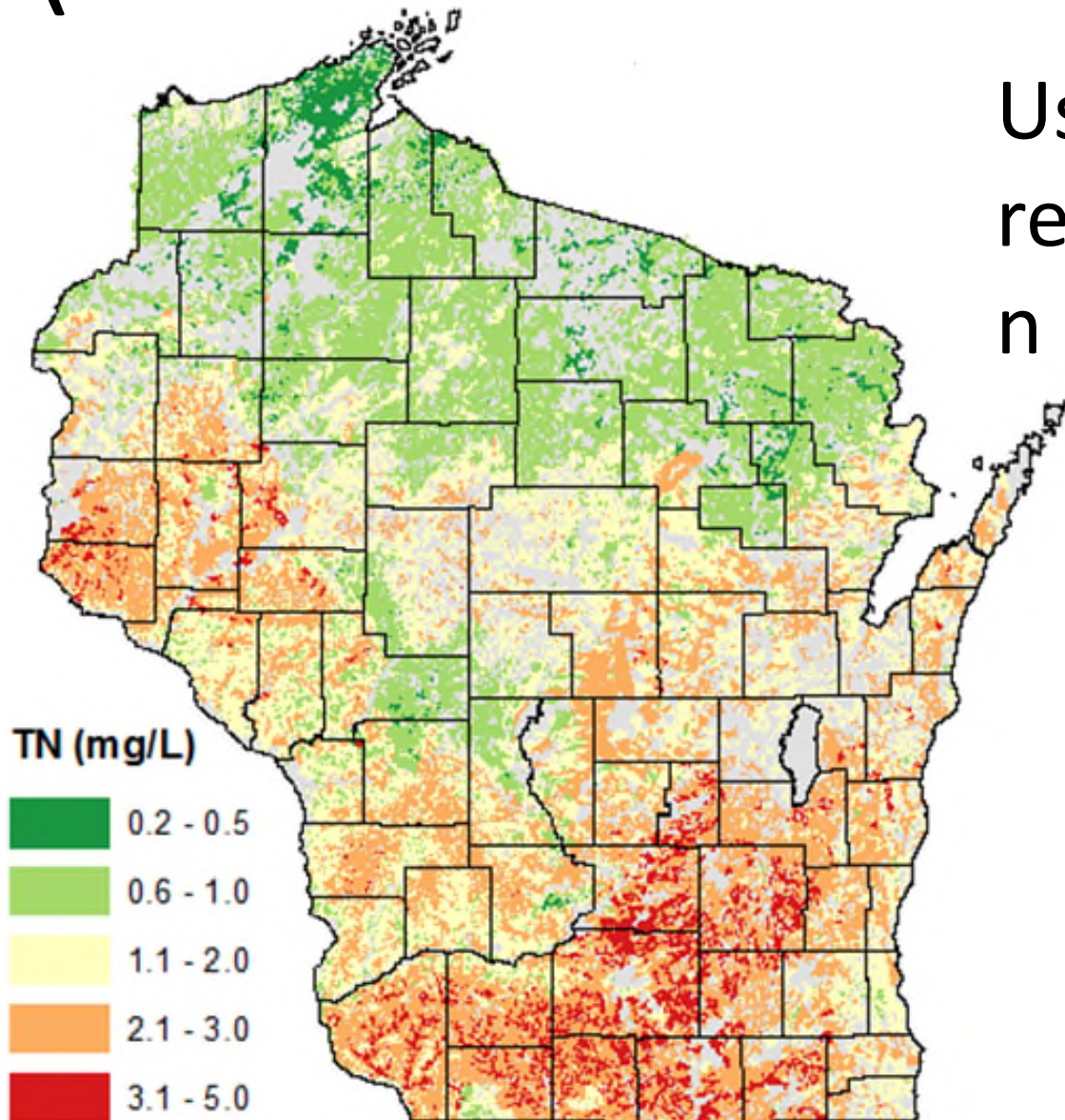
WI Hydrography Dataset
100s of attributes, e.g.

- Land cover
- Topography
- Soil and bedrock
- Hydrology
- Channel features
- Climate
- Meteorology



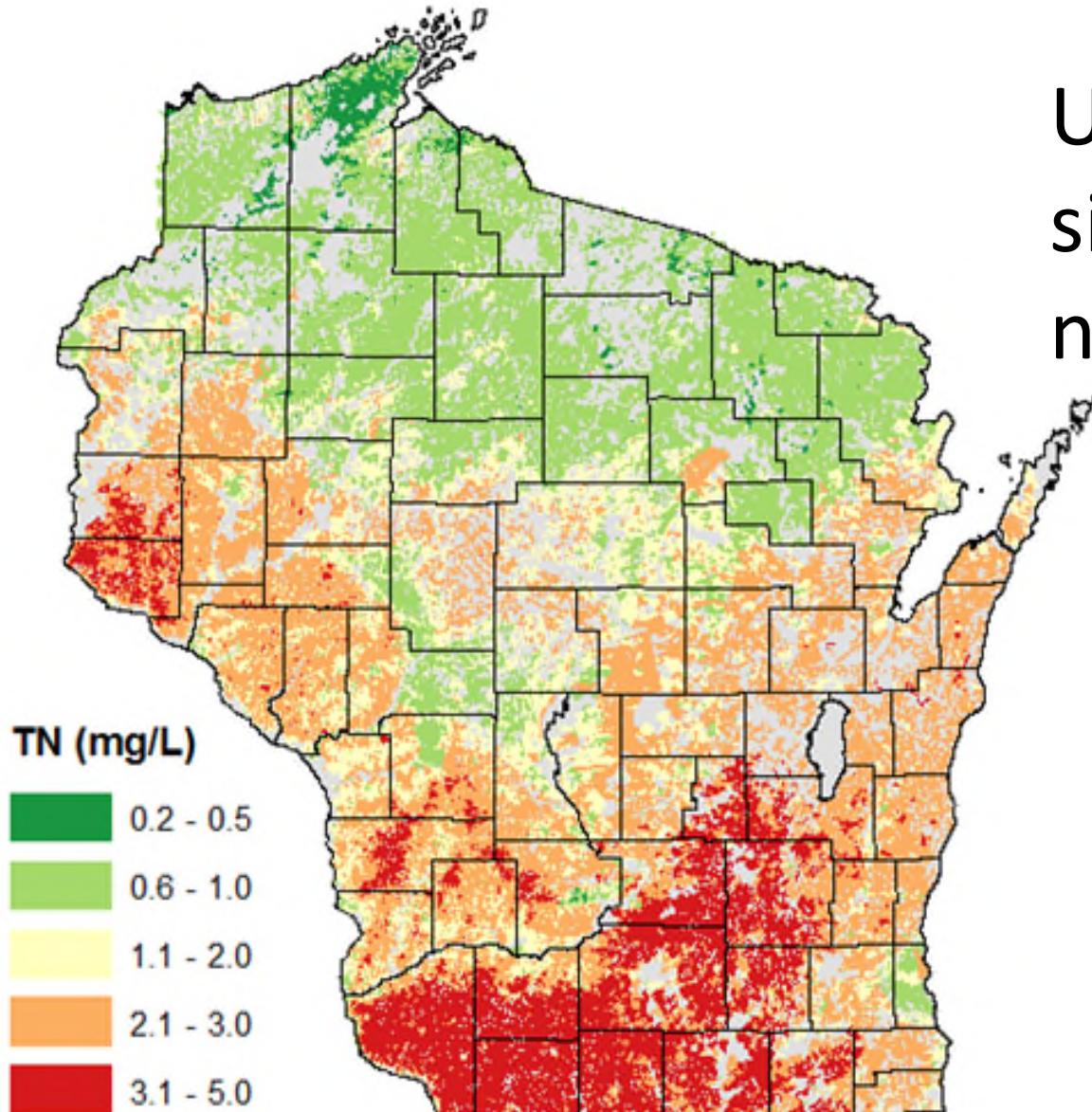
Random Forests Results (Current conditions)

Used all sample sites data
regardless of quality.
 $n = \sim 2,000$



Random Forests Results (Least-disturbed conditions)

Used least – disturbed
sites data only
n = 178



Also . . .

Expectations using Least – disturbed sites data are still largely driven by disturbance

Parameter	<i>n</i>	<div><div>NSE (Tng)</div><div>Ag/Urban</div><div>Forest</div><div>Wetland/Lake</div><div>Slope</div><div>Soils</div><div>Geology</div><div>Stream flow</div><div>Water temperature</div><div>Channel</div></div>									
TP	242	0.51	5	1	1		2	1			
TN	178	0.72	5	1			2	2			
DIN	215	0.72	4	1	1		3	1			
Conductivity	150	0.76	5	1			2	2			
TSS	153	0.40	4		3		3				
Transparency	192	0.27	3	1			5		1		
DO	212	0.15	3	2	1	2	1			1	

Top 10 predictor variables

Conclusion #2

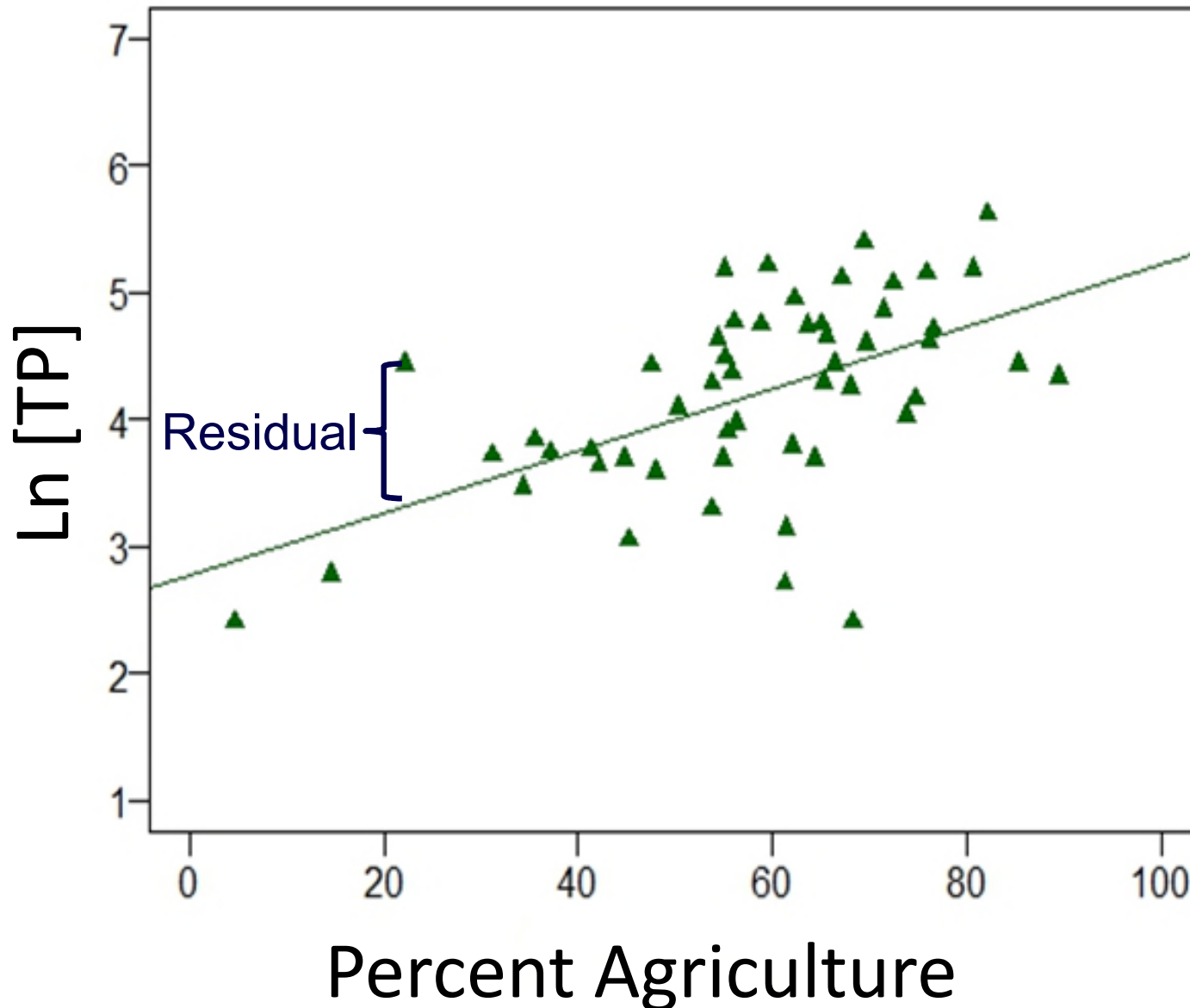
Use caution when drawing conclusions from least - disturbed reference sites input data.

Potential solution:

Account for differences in land use disturbances in stream model input data.

Controlling for site-quality differences

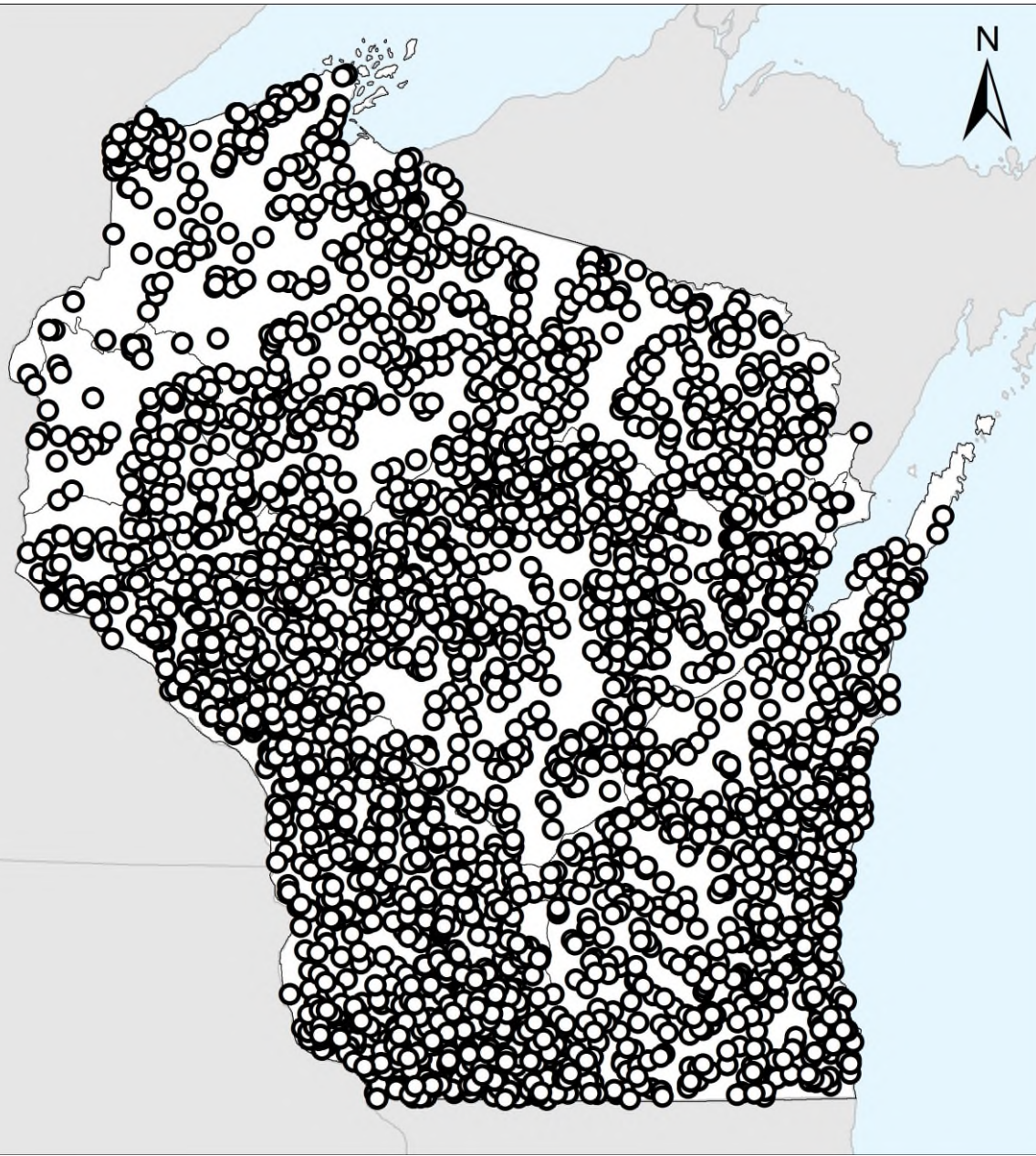
(use residuals to adjust for land use, TP example)



Residuals used as the response variables in the RF models
(Robertson et al. 2006)

Not limited to reference sites data only

○ = sample site (2003 – 2013)

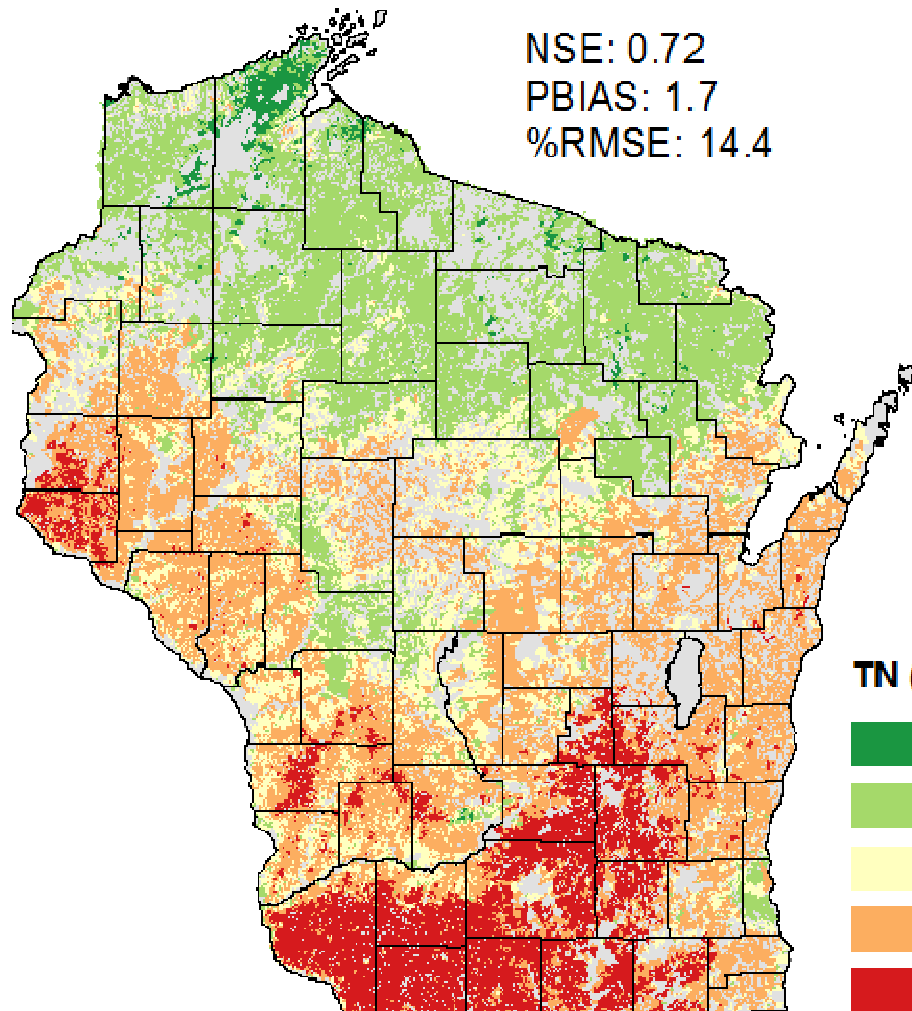


Habitat	n = 1,500
Chem.	n = 2,000
Inverts	n = 3,200
Fish	n = 1,000

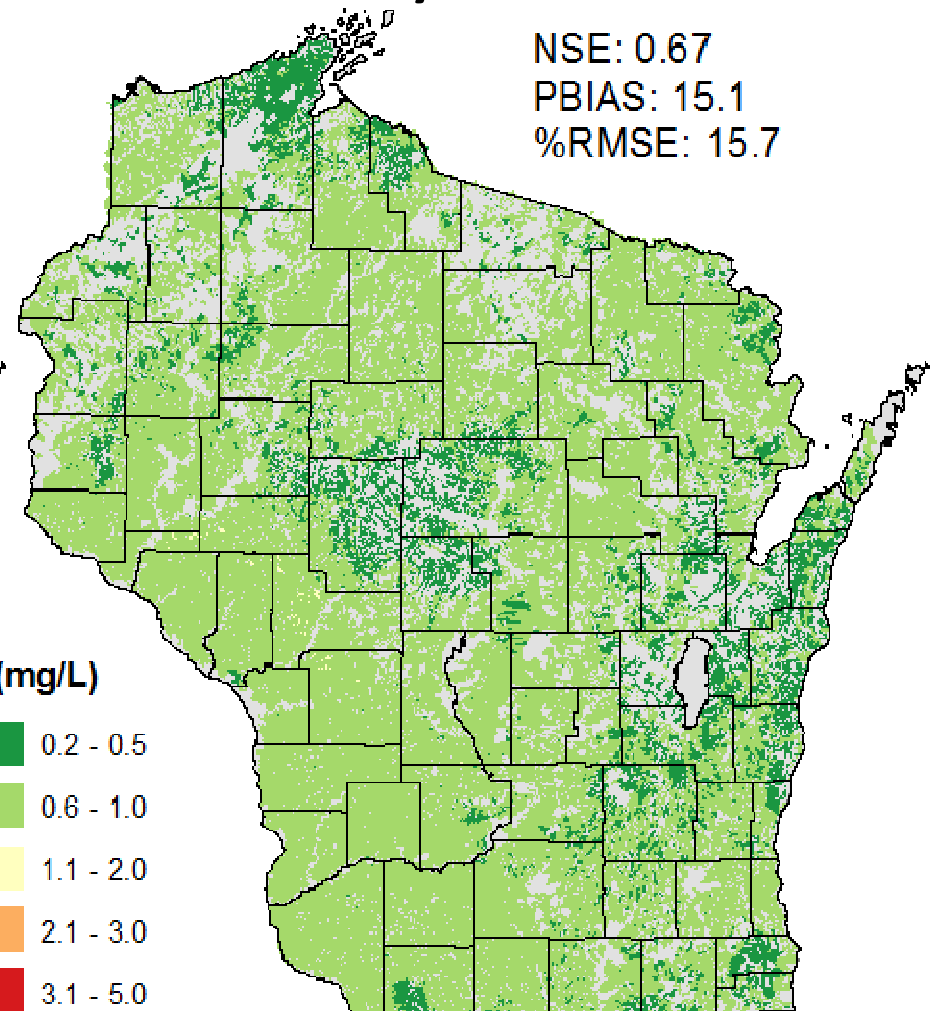
Conclusion #3

Adjusting for land use often resulted in very different expectations

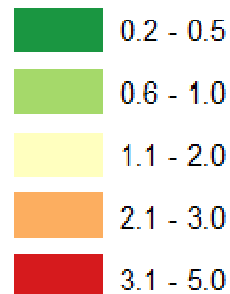
Least - disturbed



Minimally - disturbed



TN (mg/L)



Random Forests Models Predictive Power

Good **Fair** **Poor** (based on: RMSE, NSE, %Bias)

Water Chemistry

Phosphorus

Nitrogen

Diss. Inorganic Nitrogen

Conductivity

Total Suspended Solids

Transparency

Dissolved Oxygen

Macroinvertebrates

Hilsenhoff's Biotic Index

Macroinvertebrate IBI

Species richness

% EPT

% Chironomidae

Feeding Groups

Fish

Fish IBI

% Lithophiles

No. Intolerant Species

% Tolerant Individuals

Habitat

Fish Habitat Index

Width / Depth Ratio

% Fine Sediment

% Rocky Substrate

% Fish Cover

Stream Reach – specific (n = 110,000)

Expectations

The screenshot displays a web application interface for stream reach data. On the left, a sidebar contains a search bar with "Results (4)", navigation links like "View History" and "View Selected", and a list of results. The first result, "Ecological expectations for wadeable streams", is highlighted in blue and includes details: "HYDROID: 200210383", "WBIC: 1221200", and "ROW Official Name: Hell Hollow Creek". Below this, there are links for "Metadata" and "Run Report", with the latter enclosed in a red box. A black arrow points from the "Run Report" link to a specific reach on a map. The map shows a network of streams in red, with a specific reach highlighted in yellow. The reach is located near the intersection of Hell Hollow Road and a road labeled "58". Other roads visible on the map include Berben Lane, German Lane, Bennett Lane, Jacob Lane, and Nee Lane. A blue button labeled "I want to..." is positioned at the top of the map area.

Results (4)

[View History](#) [View Selected](#)

[Refine Results](#) | [Table View](#) | [Charting View](#)
[Export to Shapefile](#) | [Select All](#) | [Select None](#)

[Ecological expectations for wadeable streams](#)

★ [HYDROID: 200210383](#)
WBIC: 1221200
ROW Official Name: Hell Hollow Creek
[Metadata](#) | [Run Report](#)

Hell Hollow Creek

Richland

Unnamed

Study Conclusions:

- Ecoregions may differentiate streams, but difficult to separate natural from anthropogenic differences.
- Caution is required when drawing conclusions using least - disturbed reference site data.
- Adjusting for land use may provide better estimates of stream expectations.

A photograph of a river with sunlight reflecting off the water's surface, creating a shimmering effect. The water is dark, and the reflections are bright and numerous. The background shows a dark, forested bank.

Questions?

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